CAIT
Center for Advanced Infrastructure & Transportation
Rutgers, The State University of New Jersey

NJDOT Bureau of Research
QUARTERLY PROGRESS REPORT

Project Title:	Development of Airport Obstruction Identification System
RFP NUMBER:	NJDOT RESEARCH PROJECT MANAGER: Ed Kondrath
TASK ORDER NUMBER: 115 / 4-26857	PRINCIPAL INVESTIGATOR: Patrick Szary
Project Starting Date: : 01/1/2002 **Original** Project Ending Date: 12/31/2003 **Modified Completion Date:** 12/31/2005	Period Covered: 3rd Quarter 2005

Task	% of Total	% of Task this quarter	% of Task to date	% of Total Complete
1. Literature Search	10%	0%	100%	10%
2. Develop criteria	5%	0%	100%	5%
3. Evaluate the cost effectiveness	8%	0%	100%	8%
4. Conduct laboratory experiments	5%	25%	90%	4.5%
5. Conduct laboratory/field experiments	15%	15%	93%	14%
6. Develop prototype software	25%	0%	80%	20%
7. Demonstrate field test system	5%	0%	90%	4.5%
8. Redesign a new prototype	5%	25%	100%	5%
9. Demonstrate prototype system	5%	25%	80%	4%
10. Train NJDOT personnel	7%	0%	75%	5.25%
11. Final Report	10%	10%	50%	5%
TOTAL	100%			85.25%

Project Objectives:
The objective of this research is to develop a prototype system for easily acquiring data either at fixed intervals or over time and generate a tree removal/trimming plan for discretized trees/tree areas. The areas could be identified using Global Position technology or produced using purchased aerial satellite photographs of the surrounding airport space.

Project Abstract:
The Division of Aeronautics is statutorily obligated to identify all obstructions to the approaches at the State's public use airports and heliports; and to have these obstructions removed. The first line of trees may be shadowing other obstructions that are not visible until the first line of trees is removed. Since tree removal/trimming often impacts surrounding landowners, multiple cuts or frequent removals are not desirable and in some jurisdictions are not feasible. The goal of this research is to provide the state with a device or methodology to identify a tree removal/trimming strategy for an annual cut where the trees surrounding the airport will remain within regulations.

1. Progress this quarter by task:

A. The Bergen unit has been test flown and a test installation of the copilot was done on one of the Raptors. Progress with the camera mount has continued. The mount has been modified to fit our application's needs. The pan servo was removed and pan axel is set screwed in place so that the camera will always point straight in the direction of the helicopter. The tilt servo had to be modified so that it could respond to angular inputs instead of rate inputs. A modified servo mount was fabricated to attach an external servo gearbox and potentiometer. This new installation supplies greater torque and has 180 degrees of position sensitive travel. Now the tilt servo has the ability to be programmed to certain angles of tilts which can be accessed from the 3-button switch on the 9C radio.

B. Research has been done and a servo controller has been found to allow the programming of a routine which could send the tilt to different angles and take a picture at each angle. Gentled camera remote control LED shutter control and zoom control transmitters were purchased and installed. These microprocessed LED's provide the same functioning as the RM-1 remote control that comes with the digital camera, however these can be controlled from the radio receiver.

C. The camera mount is completed and allows full remote functioning of tilt, shutter, and zoom as well as being set up for a feedback downlink from the camera which will allow the camera operator to watch exactly what the camera is recording on a small monitor form the ground. The firmware for the gps unit was upgraded as was the data link software. Experimentation with GPS functions has been done.

D. Experimentation and research has been done into a method of recording the helicopter's orientation and heading in flight which would be correlated to each image. The GPS supplies the (x,y,z) coordinates of the helicopter, but the heading and orientation are also required in order to process the set of images to generate 3-D maps. The image processing is very sensitive to these angles. Options such as assuming the camera mount is parallel with the ground, calibration of the tilt angles relative to the camera platform, and measuring camera's heading with sensors that reference the earth's magnetic field would provide too much error.

E. Progress has been made using an image analysis method that would require that there to be at least two identifiable objects in each image taken in which the objects could have their physical (x,y,z) coordinates measured. Then an algorithm uses the coordinates of these two objects and the helicopter's coordinates along with the image to calculate a two unit vectors in space, one pointing in the direction of the camera's exact view (direction normal to the plane of the image), and the other pointing in the physical direction corresponding to the horizontal axis of the image. The algorithm has been developed and is being tested.

F. Trainings have been halted temporarily until the unit has been completed. At that point trainings can resume and the project can move toward completion.

2. Proposed activities for next quarter by task:

A. The completion of the integration of the Bergen Industrial Twin and outfitting the unit with all the necessary components for testing.

B. A beacon antenna and support equipment needs to be purchased for the gps unit so that we can acquire the quoted accuracy of about 80 cm in 20 seconds. The gps unit must be tested and its functionality confirmed. The gps antennae require a clear view of the sky which leaves mounting of the antennae a challenge. Side structures that will allow mounting of the gps antenna outside the shadow of the main blades need to be fabricated and mounted to the helicopter undercarriage. It is not certain at this point how long these side trusses need to be but we will start by mounting the antennae out as far as the blade's span. The gps unit needs to be mounted in a metal enclosure to shield it from the electromagnetic interference generated by the ignition coils of the engine and metal to metal contact of the helicopter drive train.

C. Once the gps and antennae can be mounted, tests of the gps's ability to record a signal with the helicopter running need to be done. We need to verify that the gps can record the helicopter's position in a short enough amount of time that the helicopter hasn't drifted substantially within the time after an image is taken. If the current setup can provide such functioning then we will test fly the helicopter and start taking aerial pictures. Then we can start providing images and coordinates to the software engineers so that they can verify whether the 3-D maps generated correspond to actual dimensions of the location.

D. Test flying the helicopter at the chosen airport and sending acquired images to Oakland University for post processing and producing a detailed map.

E. Continuation of work on the final report.

3. List of deliverables provided in this quarter by task (product date): n/a

4. Progress on Implementation and Training Activities:

5. Problems/Proposed Solutions:

Total Project Budget	$210,000.00
Modified Contract Amount:	
Total Project Expenditure to date	$112,733
% of Total Project Budget Expended	54%

These are approximate expended amounts for the project; these estimates are for reference only and should not be used for official accounting purposes. For a more accurate project accounting please review the quarterly invoice for this project.